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D:E:Davy
1792.

A
SHORT ESSAY
ON THE
PROPAGATION and DISPERSION
OF
Animals and Vegetables.

BRITISH MUSEUM

A
SHORT ESSAY
ON THE
PROPAGATION and DISPERSION
OF
Animals and Vegetables,

BEING CHEIFLY INTENDED AS AN
Anſwer to a Letter lately publiſhed,
And ſuppoſed to be written by
A GENTLEMAN of EXETER,
IN FAVOUR OF
EQUIVOCAL GENERATION.

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By Wm. Elford Esqr. ~~of~~ Bickham, Co.
Devon, crd. a Bart., 26. Nov. 1800.
Died S.p. 1837.

BRITISH MUSEUM

TO

JOHN ARSCOTT, Eſq.

OF *TETCOTT*.

Dear Sir,

AS my intention in the following Eſſay is to point out ſome inſtances of the wiſdom, power, and goodneſs of the Almighty in the works of his creation, and to reſcue them from the ſtigma of having been produced by chance; I wiſh to commit it to the patronage of a man, who, to a moſt extenſive acquaintance with, and admiration of thoſe works, joins the beſt acknowledgment of their divine Author, by an exemplary practice of all the duties and exerciſes of religion.

The common language of dedication would ill apply to one of thoſe very few individuals, who ſtill preſerves that hoſpitable, and moſt reſpectable character of an Engliſh Country Gentleman.

Some apology is neceſſary for prefixing your name to ſo trifling a performance. I cannot, perhaps, make a more acceptable one, than, that the importance which it may take from yourſelf, will accrue to one whom you have honoured with the name of Friend.

I am, dear Sir,

With great truth and reſpect,

Your moſt obedient

And faithful Servant.

PRE-

PREFACE.

THE weight of a man's opinions is in proportion to his general character in the world, and as that of the reputed author of the letter alluded to in the following Eſſay, ſtands very deſervedly high in many reſpects, his arguments may from thence have obtained an influence, to which their futility by no means intitles them. The great caſe with which moſt of them were to be confuted, encouraged a weak advocate to undertake the taſk. Had greater knowledge and ability been employed, much more might certainly have been ſaid on ſo ample a ſubject. As truth however is the beſt companion in an argument, I truſt I have not altogether failed in my object.

Many of the obſervations have been taken from different writers, and I have always mentioned my authority whenever I have recollected it.

Some were communicated by friends, a few are my own, and others have been ſo long entertained by me, that I know not whence they originated.

It has been remarked, I believe, by the famous Duke of Dorſet, that the little monoſyllable *I*, gives an air of vanity to the moſt plain and ſimple diſcourſe. The reader is requeſted to keep this in his recollection, while he peruſes the following pages, and to be aſſured that the too frequent introduction of it, proceeded only from a want of practice and ſkill to do otherwiſe.

A

SHORT ESSAY, &c.

IN peruſing two ſmall volumes of Letters, ſuppoſed to have been written by a Gentleman of Exeter, I ſaw, with great ſurprize, an attempt made in one of them to revive the exploded and pernicious doctrine of ſpontaneous production, or the production of Animals and Vegetables by putrefaction, fermentation, &c.

As it is my intention to controvert what is advanced on the ſubject, it will be neceſſary to make ſeveral quotations from the Author's Letter, and leſt his meaning may not be perfectly underſtood, I ſhall firſt give his definition of it in his own words:

"There is ſomething in the ſound of "ſelf-production, which ſeems like a "contradiction: I mean nothing more "by it, than that a vegetable or animal "does in many inſtances firſt exiſt by a "different principle, than that upon "which the ſpecies is afterwards conti-"nued. As the term does not exactly "expreſs this, it may eaſily be perverted "from the ſenſe in which I wiſh it to be "underſtood."

In an age, in which the ſtudy of natural philoſophy and hiſtory ſeems chiefly to have prevailed, and in which ſuch conſiderable advances and diſcoveries have been made in both, I cannot but be aſtoniſhed, that any man ſhould entertain, much leſs that he ſhould publiſh and avow, principles ſo replete with abſurdity and impiety.

Its impiety is ſuch, that were it admitted in its full extent, abſolute Atheiſm would be eſtabliſhed.

The Scripture tells us, that in the beginning God created all things; and that at the general Deluge, he ordered Noah to build an ark, and take into it his own family, and a male and female of every kind of animal, for the expreſs purpoſe of "*keeping ſeed alive upon the* "*face of all the earth.*"

Thus were all things created, and preſerved. But as the Author has avoided all religious conſiderations of his ſyſtem, and has appealed only to reaſon and philoſophy in ſupport of it, I ſhall endeavour to convince him of its abſurdity, and that on theſe grounds his premiſes are falſe, and his concluſions erroneous.

He ſets out with ſaying, That after giving every theory of the earth a patient reading, he thinks it probable, that the whole world was originally covered with water to the depth of three miles, and adds, "I conſider all Continents as a "congeries of Iſlands, heaved up from "the bottom of the Sea at different "times by volcanoes and earthquakes."

How far this ſyſtem may be true, I do not preſume to judge; nor can I conceive how it relates to the matter in queſtion, unleſs the Author means to prove much more than he profeſſes, (to wit) that after theſe volcanic eruptions and earthquakes had raiſed Continents and Iſlands out of the water, the whole animal and vegetable world was originally ſelf-produced from the ſlime and mud with which their ſurfaces were covered.

That all his ſubſequent arguments tend to this point is very certain, and if ſuch are his ideas, I heartily pray God to open his mind to views leſs dreary and comfortleſs, and to inſpire him with ſentiments leſs deteſtable. As however the Author has not profeſſed ſuch tenets, I will not attribute them to him;

and will rather impute his having uſed inapplicable arguments, to the badneſs of his cauſe, than to his religious incredulity.

He next proceeds to put a caſe hypothetically, of a new Iſland juſt lifted out of the ſea. "The marine ſubſtances by "degrees decay, moſs appears, graſs "ſucceeds, then the ſmaller kinds of "plants, buſhes, and trees." All this is readily admitted: The ſmaller kinds of vegetables only can grow firſt, for want of a ſufficient mould; as theſe by degrees vegetate and decay, more mould is formed, and larger vegetables find nouriſhment, whoſe ſeeds had laid dormant, till that event took place: But ſurely no argument for equivocal generation can be drawn from thence; the ſame proceſs obtains in places, where we need not look for ſpontaneous production to account for it. Whenever a bed of lava is formed from the eruptions of a volcano, although it flows into a valley ſurrounded by all kinds of vegetables, the ſurface of it receives them in the rotation above ſtated; and indeed Mr. Brydone ſays, that Recupero, the hiſtoriographer of Mount Ætna, had made his calculations of the age of each ſtratum of lava, by the depth of the mould between them.

The Author then adds, "Let us pro-
" ceed from reaſoning to facts. Some
" Voyager diſcovers an Iſland evidently
" formed by a volcano, and very remote
" from other countries; it is a perfect
" wood to the water's edge, *has ſome*
" *plants which exiſt no where but in that*
" *ſpot*, together with others common to
" places in the ſame latitude: Now,"
he adds, " if *every one* of theſe or-
" ganized bodies was not *brought there*,
" ſomething muſt be ſelf-produced."

When a man ſtates what he calls facts, on which he forms a ſyſtem, he ought to ſtate alſo, from whence he takes them, and on whoſe authority he lays them down. What Voyager has diſcovered an Iſland, in circumſtances preciſely agreeable to this deſcription? I have never heard of ſuch a one. The fact is, animals and reptiles are ſeldom found in uninhabited or unfrequented Iſlands, as will be more fully ſhewn in the ſequel: Birds and inſects have means of conveying themſelves thither; and as to ſome plants known in no other place, all that a Voyager can poſſibly ſay is, that he has not ſeen, or at leaſt not obſerved, ſuch plants before. The truth is, that before Sir Joſeph Banks and Dr. Solander circumnavigated the Globe, no accurate botaniſts examined the vegetable productions of new-diſcovered countries; and to common and unſcientific obſerſervation on ſo obſcure and difficult a ſubject as botany, every one knows how little attention ought to be paid.

If therefore the Author thinks proper to lay down facts, which have neither proof nor even probability for their baſis, it will not be conſidered as any conſcious weakneſs of the argument I am endeavouring to ſupport, that I do not attempt to reaſon upon them. I have already pointed out thoſe which are unfounded and improbable, and will now endeavour to convince him, that there are various natural cauſes, by which a new Iſland may receive ſuch animals and vegetables as are found upon it.

The action of the air, and of heat and moiſture, are abſolutely neceſſary to vegetation; and it is perfectly well known that the vegetable principle in ſeeds will lie dormant a great number of years, where this action is wanting; this is ſo unqueſtionable as ſcarcely to require any proofs; I will however mention a few. Seeds kept by gardeners and ſeedſmen will retain it many years, but theſe will after a certain time decay; Nature herſelf, however, is the beſt preſerver of her own productions, and accordingly ſeeds which happen to be buried in the ground too deep for the action above mentioned, will retain their powers for any length of time, and will vegetate when they are again expoſed to it. I have frequently ſeen muſtard plants growing on a bank of earth, which had been juſt taken from a pit many feet below the ſurface, and which, from the appearance of the ſtrata, had lain undiſturbed for ages. I have taken more earth from the ſame pit, and on examining it have diſcovered muſtard ſeeds, have ſown them in freſh earth, and ſoon ſeen them grow with the greateſt vigour.

As Nature then has the power of preſerving this vegetative principle in ſeeds, by the mere excluſion of them from the air, an Iſland formed by a volcano muſt be amply provided with them at it's firſt emerſion; ſome of which had lain in the bowels of the earth ever ſince the flood, and others been depoſited on the bed of the ocean by daily accumulation. Seeds too are conſtantly wafted by the air in every direction, from Iſlands and the banks of neighbouring Continents; ſuch of them as light on the Sea, and are ſufficiently buoyant, are carried about until they meet with ſome land, on which they are depoſited.

A curious example of this, is related in Capt. Cook's laſt Voyage. It was his opinion, that many of the Iſlands diſcovered in the Pacific Ocean were not formed by volcano's, but were produced by the ſlow growth of coral rock, and the gradual acceſſion of ſand and ſhells. They were obſerved in every ſtate of their progreſs. Some, which were arrived at their higheſt maturity, and were covered with vegetables, had only a very thin layer of mould, immediately under which the coral rock appeared in every part of them. Others were but juſt riſen above the level of the Sea, ſome of which had very few, and others no vegetables at all. On one of thoſe called Palmerſton's Iſlands, a few Cocoa trees and other plants were ſeen juſt ſprouting up, *a few inches above where the Sea had reached*, and on others, the various plants which grew neareſt the ſhore, *were in lines parallel to it, and evidently aroſe from ſeeds brought there by the Sea.*

As I ſhall have occaſion in the ſequel to ſay much more on the ſubject of the late diſcoveries in the Pacific Ocean, I ſhall leave to that time the further conſideration of the means by which Iſlands may have received their inhabitants, animals, and other productions, and ſhall now proceed to the Author's next argument, which is this:

"Fill a veſſel with water from the "pump; it is pure, and contains neither "vegetable nor animal." Now, in order to eſtabliſh his intended deduction in favour of ſpontaneous generation, it is incumbent on him to prove, that the water is not only void of any animal or vegetable when taken from the pump, but that it does not contain the ſeeds or eggs of either, and cannot receive them from the air. That the eggs or ſeeds of ſuch minute productions as ſoon afterwards appear in the water ſhould not be viſible, will be readily admitted, when it is known, that the green ſlime conſiſts of an infinite number of minute plants adhering to one another, and that many of the animals are ſo ſmall, as not to be perceptible, but by the aſſiſtance of glaſſes. If therefore theſe ſeeds and eggs bear the ſame proportion to their future productions, as obtains in all caſes on a larger ſcale, they muſt of courſe be inviſible: But indeed other cauſes may render them ſo, ſuch as tranſparency and want of colour, even were their ſize ſuch as to form a perceptible angle on the eye.

The Author, after ſpeaking of the vegetable and animal ſubſtances which appear in the above experiment, adds, “ This ſeems the firſt ſtep towards plants “ and animals. We are told indeed

" that the animacules are from eggs laid " by flies, and the green ſlime is a plant " which has its proper ſeed—That the " water may receive both eggs and ſeeds " is highly probable, but theſe (by reaſon- " ing from other inſtances) ſeem the firſt " efforts towards animal and vegetable " life."

It is curious here to obſerve, that he admits the *high probability* of the water's receiving both the ſeeds and eggs, but yet adds, that it ſeems the *firſt efforts* towards animal and vegetable life. I own myſelf utterly incapable of comprehending what is meant by this remark. Would he have it underſtood, that from theſe minute productions thoſe of the next magnitude ariſe, and ſo on gradatim to the largeſt: If ſo, it would follow that the anceſtor of an elephant was perhaps a mite, and that a whale was begot in a remote degree by an eel in a vinegar bottle.

He proceeds, "beſides it remains to be " proved that the air ſo abounds with fly-

" ing ſeeds and inſects—If the air ſwarms
" as is ſuppoſed, viſion would be ob-
" ſtructed (as by a fog which conſiſts of
" particles inconceivably ſmall) and per-
" haps life in the nobler animals de-
" ſtroyed."

That the air does not abound in ſuch a degree, as to obſtruct viſion and deſtroy animal life is certain, becauſe we know, that viſion and animal life are not obſtructed and deſtroyed; nor was any perſon ever abſurd enough to aſſert it; but that it does greatly abound with both is as certain, and no one who uſes his eyes in a hot ſummer's day, will doubt the truth of it. It is alſo equally true and well known, that there is a regular gradation from the largeſt objects in the Creation to the ſmalleſt; the ſeed of ſome vegetables is an impalpable powder, and we are told by Mr. Leuenhoek of ſome animalcula ſo ſmall, that if a grain of ſand were broken into eight million of equal parts, one of theſe would not exceed the bigneſs of one thoſe creatures. If therefore ſeeds and inſects of a viſible ſize do float in the air, and there exiſts ſuch a gradation as above mentioned, it would be abſurd in the extreme to ſuppoſe that the ſmaller kinds do not, whoſe levity makes them ſo much more eaſily acted upon by it.

The Author adds, "If the animals and " vegetables in the above inſtance were " from eggs floating in the air, why are " the ſmaller always produced firſt? Muſt " it not ſometimes happen that ova of a " larger ſort precede the ſmaller? which " is never the caſe; not to mention the " total impoſſibility of ſome ova, particu-" larly of animals, being ſo conveyed."

In the experiment under conſideration it is moſt probable, that the water when taken from the pump, contains the ſeeds and eggs of the animal and vegetable ſubſtances which ſoon appear in it, they being both aquatics, and the water, therefore, their proper nidus; but ſhould it be allowed that this is not the caſe, ſurely the Author has urged nothing againſt the probability of their being depoſited there afterwards from the air: What he ſays only goes to prove, that large animals are not produced from the eggs of ſmall ones. No large animals ever appear in this experiment, and therefore it is not a matter of conſideration, whether their ova can be conveyed by the air or not: But were it granted that they could be ſo conveyed, that they fell into the water, and did not there come to maturity, what follows, but that the water was not their proper nidus.

The Author next adduces the animalcules diſcovered in an infuſion of pepper in water, and argues thus: "Can we "ſuppoſe the fly which lays the egg from "which this creature exiſts, continues "floating in the air until ſome philoſopher "makes a mixture proper for its depoſit? "Is it done often enough to preſerve the "ſpecies? What muſt the fly have done "before pepper was brought from India?

“ You may tell me that the egg was depoſited there—Well then, if the eggs “ are not hurt by the pepper being dried “ in an oven, happen to be brought to “ Europe, and fall in the way of a naturaliſt, the ſpecies is preſerved.”

He ſays, in a ſubſequent part of his Letter, “ That he has no ſyſtem to ſup“ port.” Now I beg leave to aſk him, What but a wiſh to ſupport a ſyſtem which he began to find in a tottering ſtate, could induce him ſo to miſ-ſtate and confuſe a plain and ſimple operation of Nature, by his artful manner of ſtating it? Would not any one be led to ſuppoſe, from his ſtate of the caſe, firſt, that there is no water in India, and, ſecondly, that it is neceſſary to the production of the animal in queſtion, that a *Philoſopher* ſhould make the infuſion? When the abſurdity and falſity of theſe two poſitions are conſidered, all the difficulty ceaſes.

The egg is doubtleſs depoſited on the pepper while it is growing; and as, in the common courſe of things, the pepper muſt frequently fall into water, the proper matrix is formed, and the animal produced. In order to be convinced that this is the proceſs, we need only ſuppoſe that the inſect is of the genus of thoſe which, when firſt produced from the egg, appear as aquatics, but afterwards acquiring wings, in that ſtate depoſit their eggs and then periſh. By this means too, we ſatisfactorily account for its production, in a climate ſo much colder than that in which its parent exiſted; for as the heat of water does not vary in different climates in a ratio at all equal to that of the air, the inhabitants of one will exiſt on a removal, while thoſe of the other would periſh; and whether or not the animal in queſtion ever arrives at its ſubſequent, more perfect ſtate, is nothing to the purpoſe.

At the end of the ſection from which I have laſt quoted, the Author adds, " There is great reaſon for believing that

“ the animalcule was really produced “ by the infuſion, and did not exiſt be- “ fore.” What reaſon?—I am ſure he has not given the ſhadow of one in ſupport of ſuch an opinion.

His next argument in favour of ſelf-production is the worms found in human and other bodies. Naturaliſts have long conſidered the generation of theſe worms as a ſubject of great difficulty, and have endeavoured to ſolve it by a variety of conjectures. Mr. Ray is of opinion, that the eggs of ſome of them are taken in with our food, and in ſupport of his opinion aſſerts, that children at the breaſt are rarely troubled with them, before they have uſed ſome other food—on the other hand ſome writers affirm, that a worm has been found in the ſtomach of a dead-born infant. As there are many different ſpecies of theſe worms, I own myſelf inclined to adopt both theſe opinions.

The bloſſoms of trees and plants are the repoſitories of the eggs of various inſects, and the green fruit is both a nidus and food to them. Now it is well known that thoſe people who eat a quantity of green fruit are more than ordinarily infeſted with worms. The Author, in anſwer to an argument of this kind, which he has himſelf ſtated, inſiſts on the impoſſibility of a creature, intended to live in the cold earth exiſting in the hot ſtomach. He ought however to conſider, that we can know nothing of Nature's *intentions* but by her *operations*, and that we muſt judge of the deſign, by what does really happen. There are many animals, whoſe formation enables them to exiſt in ſituations as diſtinct from each other, as the earth and the ſtomach; ſuch for inſtance are all amphibious animals, and thoſe which are known by the name of Sleepers: in both theſe caſes the facts are too numerous to be denied, and yet were we not convinced of them by daily experience, and had we only the report of others inſtead of the evidence of our own ſenſes to depend upon, we ſhould be apt to doubt whether an animal, which we ſee walking on the earth and breathing the air like ourſelves, could poſſibly exiſt under the water, or that another (the Swallow for inſtance) which while ſubject to our obſervation, appears to be almoſt conſtantly employed in collecting its food, ſhould be enabled to remain in a torpid ſtate, without taſting any thing for ſeveral months together.

For the reaſons above ſtated therefore, I have no doubt, but that ſome kinds of worms are taken into the ſtomach with our food, but I am alſo inclined to give credit to the relation of a worm having been diſcovered in the ſtomach of a dead-born infant, becauſe I am firmly perſuaded that the egg or ſeed of one kind at leaſt of theſe creatures with which the human body abounds, is taken into the circulation, from thence into every part of the ſyſtem, and is communicated by one ſex to the other, and perhaps even by mere contact. This idea I am well aware will be cenſured by many as perfectly viſionary and unfounded; but let it be conſidered, that for certain wiſe purpoſes the ſpawn and eggs of ſome animals are proportionably very much ſmaller than thoſe of others, and the ſame diſproportion is equally obſervable in ſome parts of the vegetable creation, where the ſeed of the fern, among others, though a large plant, is almoſt an impalpable powder. As the animal in queſtion therefore is intended by nature for an inhabitant of the human body, and we can deviſe no other means by which it may be communicated from one to the other, it is very fair to conclude that its eggs or ſpawn are of ſuch a texture and magnitude as is moſt proper for that purpoſe.

Another ſtriking circumſtance againſt the doctrine of worms being ſpontaneouſly generated in the body is, that the ſame perſon will in different places and climates be afflicted with different ſpecies of them, and that different claſſes of people will, in the ſame places, be infeſted with them in various degrees. Now the temperature of the human body alters very little with climate, being in all parts of the world from about 96 to 99 degrees of Farenheit's thermometer.* The Guinea worm therefore, which, in Africa, and ſeveral other countries, appears in different parts of the bodies not only of the inhabitants but of the Europeans who viſit thoſe places, cannot be ſuppoſed to be generated by the different temperature of the body, but muſt be conſidered as a native of the country where it appears, and is moſt probably taken in with the food. This doctrine is very much ſtrengthened, by the circumſtance that officers of the ſhips and regiments who viſit the parts of the world where thoſe worms abound, are much leſs troubled with them than the common ſailors and ſoldiers, whoſe food is probably more impregnated with them, or whoſe leſs delicate and cleanly habits of life, render theſe latter more likely to receive them externally.*

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* See Philoſophical Tranſactions, vol. 65. Dr. Fordyce remained twenty minutes in a cloſe room, where the air was heated to 150°; and in a ſubſequent experiment made by Mr. Banks, the room at his firſt entering it was heated to 211, but afterwards fell to 198, and yet at that very time the heat of his body was 98°, one degree only above its uſual temperature.

The Author next ſpeaks of the fiſh with which different rivers abound, ſome of which, he ſays, are peculiar to the ſingle ſtream where they are now found; This has long been conſidered as one of the moſt difficult phœnomena in nature to be accounted for, and has accordingly employed the pens of various writers. Might I preſume to form a conjecture on the ſubject, it would be this. Immediately after the flood, each ſpecies was certainly confined to a ſingle place, and was afterwards diſſeminated by various means: The ſpawn of ſome was tranſported from place to place, by ſuch birds and beaſts as uſed it for their food;* other pools and rivers were ſtocked by the induſtry of thoſe inhabitants who in a ſucceſſion of ages may have ſettled on their banks. As to thoſe kinds, which the Author aſſerts are found only in a ſingle ſtream reſpectively, (and the fact is only admitted on his authority) we may conclude, either that they never have been tranſplanted from the places in which they were originally depoſited, or that ſome particular quality in the water where they now are, renders that place only fit for their exiſtence.

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* Some writers are of opinion this worm is an aquatic, and draw this concluſion from obſerving that thoſe who have been much in the water, are particularly ſubject to them. The common ſoldiers and ſailors are more likely than their officers to bathe in exceſs, are much more expoſed to accidental moiſture, and are generally imprudent enough to remain in wet cloaths.

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* See Linnæus's Oratio de Telluris incremento, Amœnitates Academicæ, vol. II.

It muſt alſo frequently have happened that the ſurface of the world has been altered by volcanos and earthquakes, and thus the courſe of rivers been either in part or altogether diverted; by which means large pools and lakes have been left in ſome places, and in others, the ſtream having been ſtopped on the ſurface, has found a ſubterraneous paſſage, and thus communicated its productions to other diſtant rivers. Italy affords more than one inſtance of each of theſe phenomena, occaſioned by violent convulſions of nature; and doubtleſs remote and uninhabited parts of the world have undergone ſimilar revolutions, and thus large lakes have been found in the midſt of foreſts, without any apparent ſources from whence their water or productions were derived.

The Author afterwards adds, "I may "ſtrengthen every thing I have advanced "on ſelf production with additional arguments, and thoſe from inſtances on the

" largeſt ſcale. The Old and New Con-
" tinents are two immenſe Iſlands: You
" will get little by ſuppoſing them once
" joined at Kamſkatcha; what ſhould
" ever induce thoſe animals which are
" never ſeen out of a hot climate, to tra-
" vel ſo far North as the Strait between
" the Continents? They do not approach
" it now, why ſhould they then? Beſides,
" has not each Continent ſome creature
" peculiar to itſelf? Did thoſe in Ameri-
" ca come from countries where no ſuch
" animals exiſt? If they did not, and are
" found in America only, what is the fair
" concluſion?

The mode of argument here adopted is very curious: He firſt inſinuates, that the animals on both Continents are in many inſtances the ſame, and afterwards ſays they are in ſome caſes very different; but would have it underſtood that both theſe circumſtances are favourable to his ſyſtem, and are equally proofs of ſelf production.

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The plain ſtate of the caſe is this—The two Continents do approach ſo near to each other at Behring's Straits, and the two oppoſite capes of Eaſt, and Prince of Wales have ſuch a projection towards each other, that it is the unanimous opinion of the great circumnavigators who lately viſited thoſe parts of the world, that they were formerly joined at that place. The diſtance is not now more than twelve or thirteen leagues, and has moſt probably been encreaſing to that extent for many ages paſt. But indeed the queſtion, whether or no the Continents were formerly joined at Behring's Straits need not reſt on conjecture, ſo far as it relates to the paſſage of animals from one to the other, for being in between 60 and 70 degrees of northern latitude, the ſea muſt, every winter, be ſufficiently frozen for that purpoſe.

Now it is a fact, as remarkable as it is true, and which therefore ought not to have eſcaped the Author's obſervation, that the animals which inhabit the northern parts of both the Continents are the ſame, ſuch as bears, foxes, Polecats, &c. and that thoſe which, when America was diſcovered, were found in the ſouthern parts of each, within or near the tropics, were totally different, without a ſingle exception. Dr. Robertſon adduces this very circumſtance as a proof that the Continents were formerly joined at the northward, and that moſt probably, America was peopled from that part of Europe.

I cannot but remark here, that although the population of America has been the ſubject of various theories and conjectures, and has by different writers been ſeverally attributed to the Jews, the Canaanites, the Phœnicians, the Carthagenians, the Greeks, and the Scythians, yet that, however they differed as to the place or people from whence this population was derived, they all agreed that it was from ſome place or other, and the idea of the inhabitants having been ſelf-

produced,

produced, never entered into the head of the moſt viſionary writer on the ſubject. That this is our Author's opinion I will not preſume to aſſert, but I own I cannot ſee to what other point his arguments tend.

From what has been ſaid above, theſe two concluſions ſeem to follow; That as the animals which are common to both the Continents, are found in, and are proper only to, the northern parts of each, they migrated from one to the other; and that thoſe to the ſouthward are different every inſtance, becauſe from the great breadth of the Pacific Ocean near the line, no migration could there take place.

I ſhall now endeavour to point out by what means, iſlands and places more remote from each other than ſome parts of the two Continents, may have received their inhabitants and mutual productions, and ſhall appeal to thoſe lights which late diſcoveries have thrown on a ſubject, that at the firſt view ſeems to be attended with much more difficulty than the particular inſtance, which the Author has thought proper to adduce in ſupport of his hypotheſis, and which I have already combated, I hope, with ſucceſs.

Navigation, as far as ſailing coaſtwiſe may be termed ſo, is ſo obvious an art, that, if I recollect right, there is but one place among all thoſe lately diſcovered by Captain Cook and others, where it is not practiſed.

In the earlieſt ages of the world, long before the uſe of the compaſs was known, it was carried to a pretty great degree of perfection by various nations, who as their civilization and knowledge in aſtronomy and geography increaſed, were infected with the rage of diſcovery. Thus the Phœnicians, the Egyptians, the Greeks, the Romans, and Carthaginians, formed communications ſucceſſively between different parts of the world, tho' on no very extenſive ſcale; but the latter went ſo far, as to diſcover the Canary Iſlands.

As it has never been known however, that any of theſe nations doubled either of the Capes*, or even viſited the eaſtern coaſt of America, we muſt look to thoſe very numerous expeditions on diſcovery which took place in the 15th, 16th, and 17th, Centuries, from different parts of Europe, to account for the appearance of ſome European animals on the coaſts and iſlands of the vaſt north and ſouth Pacific Ocean.

It is well known that the Spaniards for the convenience of their ſhips, placed ſeveral kinds of animals on ſome of the iſlands which they diſcovered, and ſome doubtleſs eſcaped from the wrecks of thoſe ſhips which were loſt on the coaſts of others.

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* The Biſhop of Avranches, in his hiſtory of the commerce and navigation of the ancients, aſſerts that the Cape of Good Hope was known, frequented, and doubled, in Solomon's time; as this, however is not a general opinion, it is not here inſiſted on.

To accident alſo as well as to deſign muſt be attributed the very wide and extenſive communication, which it will be clearly proved has taken place, between that immenſe range of coaſts and thoſe numerous cluſters of iſlands lately diſcovered by our own circumnavigators.

In the courſe of ages it muſt have happened that canoes were ſometimes driven by ſudden tempeſts from the ſhores on which they were ſailing, and forced on other ſhores and iſlands unknown before; and that by this means new colonies were formed, and domeſtic animals tranſplanted.

One event of this kind fell under the obſervation of Captain Cook during his laſt voyage, the circumſtances of which are thus related. Omai happening to go on ſhore on the newly-diſcovered iſland of Wateeoo, was ſtrangely ſurpriſed at ſeeing among the crowd aſſembled on the ſhore, three of his own countrymen, natives of the ſociety iſlands. The diſtance between theſe places is at leaſt two hundred leagues acroſs an unknown ocean, which they had traverſed in a ſmall open canoe, fit only for a paſſage where the ſight of land is never loſt. Their ſtory as related by them is, 'That about twenty perſons of both ſexes, embarked on board a canoe at Otaheite, to croſs over to the neighbouring iſland of Ulietea. A violent contrary wind ariſing, they could neither reach the latter, nor get back to the former. Their intended paſſage being a very ſhort one, their ſtock of proviſions was ſcanty, and ſoon exhauſted. The hardſhips they ſuffered, while driven along by the ſtorm they knew not whither, are not to be conceived. They paſſed many days without having any thing to eat or drink. Their numbers gradually diminiſhed, worn out by famine and fatigue. Four men only ſurvived when the canoe overſet; and then the perdition of this ſmall remnant ſeemed inevitable.

However, they kept hanging by the ſide of their veſſel, during ſome of the laſt days, till Providence brought them in ſight of the people of this iſland, who immediately ſent out canoes, took them off the wreck, and brought them aſhore. Of the four who were thus ſaved, one was ſince dead. The *ſimilarity* of *manners* and *language* had more than naturalized them to this ſpot.'

Captain Cook afterwards adds 'The landing of our Gentlemen on this iſland, cannot but be conſidered as a very fortunate circumſtance. It has proved, as we have ſeen, the means of bringing to our knowledge a matter of fact, not only very curious but very inſtructive. The application of the above narrative is obvious. It will ſerve to explain better than a thouſand conjectures of ſpeculative reaſoners, how the detached parts of the earth, and in particular how the iſlands of the ſouth-ſea may have been firſt peopled; eſpecially thoſe that lie remote from any inhabited continent, and from each other*.

But Captain Cook and his companions found that a moſt extenſive communication muſt formerly have taken place, either by accidents ſimilar to that above related, or others now unknown, and indeed perhaps from intentional migration between all, or the greateſt part of thoſe coaſts and iſlands which they viſited in the vaſt Pacific Ocean; and this concluſion is drawn, principally from three circumſtances, in which their ſeveral inhabitants agreed; their language, their manner of treating the dead, and their religious ceremonies.

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* See Cook's laſt voyage, vol. I. page 202, for a more full account of this matter; and alſo a note in the ſame page, where two ſimilar accidents are related. In 1696 two canoes, having on board thirty perſons of both ſexes, were driven by contrary winds and tempeſtuous weather, on the iſle of Samal, one of the Philippines, after being toſſed about at ſea 70 days, and having performed a voyage from an iſland called by them Amorſot, 300 leagues to the eaſtward. Two other canoes, one containing twenty four and the other ſix perſons, men, women, and children, were driven from an iſland called by them Farroilep, after a voyage of 20 days, to one of the Ladrone iſlands. Theſe two relations are quoted by Captain Cook, from *Lettres Edifiantes & Curieuſes,* Tom. XV. page 196.

The proofs which are drawn from the two latter circumſtances, tho' very ſtrong, are not of equal weight with that of the former. The ideas of a ſupreme being, and a veneration for the dead, are almoſt univerſal; and a real or fancied ſimilarity in the mode of addreſſing and worſhipping the one, and of treating the other, might poſſibly have obtained among nations who never had any kind of connection with each other. But the voyagers collected from the various tribes which they viſited ſpecimens of their reſpective vocabularies, by which it appears, that the names of perſons and things were in many inſtances literally the ſame, and that in others they did not differ more, tho' in places extremely remote, than thoſe of our own language do in different parts of the empire. Now as the names of perſons and things are mere arbitrary diſtinctions, and can have been

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directed by no external cauſes or objects, the evidence which ariſes from a general ſimilarity, and in many inſtances an identity of language, amounts to ſuch a proof of a common origin, as can leave no doubt on the minds of the moſt incredulous.

That the Caroline and Ladrone iſlands, which lie ſo many degrees to the Weſt and North Weſt, are alſo inhabited by the ſame people, is very clearly demonſtrated, by a general prevalence thro' all of them, of nine religious, political, and domeſtic cuſtoms, which are particularly noticed in Captain Cook's laſt voyage*.

Through the ſame channels of communication, whatever they may have been, by which the inhabitants of theſe diſtant regions have paſſed from one to the other, it is reaſonable to conclude, that many of their animal and vegetable productions have alſo been tranſplanted; and this concluſion ariſes from a fact, which carries conviction with it. Thoſe vegetables which are fit for food are found almoſt without exception in all the iſlands: and the only Quadrupeds which abound in any of them, are of three kinds, (to wit) hogs, dogs, and rats; all of them domeſtic animals, and peculiarly adapted to living on ſhip-board. The two former being conſtantly uſed by the inhabitants for food, were of courſe taken with them when migration was their object, and were likely to be their companions when a long voyage only was intended. The latter known conſtantly to infeſt ſea veſſels, were neceſſarily communicated to thoſe places where the veſſels arrived.

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* See vol. II. page 158.

It is to be remarked, that each of the iſlands did not contain all theſe three kinds of animals, and that neither of them were found on thoſe that were uninhabited, or unfrequented, except in a ſingle inſtance, where on one ſmall iſland, a few brown rats were diſcovered; but their appearance was accounted for, by the wreck of a canoe being obſerved on the ſtrand near them.

The Author in the cloſe of his Letter, adds, "Perhaps we ſhall find that ſelf-"production ſhocks the imagination more "or leſs, according to the ſize of the thing "produced. Who would not ſooner be-"lieve, that cheeſe bred mites, than that "deſerts produce elephants? And yet," he adds, "according to our preſent Phi-"loſophy, one is as poſſible as the other."

He has here tried his doctrines by a teſt which ſhould always be applied to ſpeculative opinions: for as, in order to diſcern ſmall objects diſtinctly, we aſſiſt the defects of our bodily eye with a microſcope, ſo we ſhould aſſiſt our intellectual one, by looking on any obſcure object of our contemplation in the moſt exaggerated point of view, and by this means, its truth or fallacy will be immediately diſcovered. As the Author, however, ſeems to be too blindly attached to his ſyſtem, to have availed himſelf of the lights, which the above-mentioned trial has thrown on it, we will now candidly examine what is the reſult.

Is not every one inſtantly ſtruck with the groſs abſurdity of ſuppoſing, that an elephant can be produced out of the ſlime, mud, or ſand, of a deſert? And yet this, it ſeems, is the doctrine which the Author wants to eſtabliſh: But the folly of thinking that a cheeſe breeds mites, is not at all leſs extravagant, only leſs obvious than the former inſtance. The ideas of magnitude are merely relative, and the deluſion that ariſes from conſidering a ſmall animal as more imperfect than a large one, is only to be attributed to a want of power in our viſion, and is conſequently done away, by viewing it in a ſolar microſcope: When, by this aſſiſtance, we ſee a ſmall inſect enlarged to perhaps ten thouſand times its real bulk, we cannot but admire the exact fitneſs, ſymmetry, and proportion of all its parts, and acknowledge that the ſame wiſdom and power is as conſpicuous in its formation, as in that of the largeſt animal of the creation. The truth therefore is, that a cheeſe produces mites, and a deſert elephants, in the ſame manner as a chimney produces young ſwallows; and it would be as abſurd to ſuppoſe that mites did not exiſt before cheeſes were made, as that there were no ſwallows before men had erected chimneys for them to build their neſts in.

In the foregoing pages I have ſhewn that many of the facts on which the Author has founded his ſyſtem, are either falſe or miſrepreſented; and where the nature of the ſubject was ſuch, that no proofs could be adduced on either ſide, and where the argument therefore muſt be founded on conjectures only, I have offered ſuch as appeared to me moſt conſonant to the general laws and operations of nature. Our only mode of reaſoning in ſuch caſes is from analogy and general principles, and as every new diſcovery in nature ſerves to confirm and ſtrengthen our belief in the exiſtence of ſuch general laws, and conſequently widens that baſis of argument, I ſhall conclude this ſhort Eſſay with a few obſervations drawn from thence.

All the operations of nature ſeem to be conducive to one general end or view, that of the continuation of all her works. The character of theſe operations, or rather of the laws by which they are carried on, is ſimplicity, and general, but not individual, uniformity: For tho' their variety is almoſt without end, yet each deviation from the general and prevailing principle is ſo ſmall, as to be always ſtrongly tinctured with, and to have an evident reference to it; like a number of radii ariſing from one centre, and all diverging from it in different directions.

The continuation of the works of nature ſeems to depend on the operation of two principles which pervade every part of them. As applied to the animal creation, they may be termed, a deſire of propagating and a care of protecting their young: in the vegetable, a conſtant tendency to produce ſeed, and an univerſal means of diſſeminating it; to which may be added a third, which is common to both, and may be called an anxiety in nature to keep every ſpecies diſtinct and unmixed from all others.

In order that I may render what will be advanced on theſe ſubjects as intelligible as I am able, I ſhall divide it into three diſtinct parts. Firſt, I ſhall conſider animal nature, ſecondly the vegetable creation, and thirdly, the admirable adaptation of the faculties and properties of each to their ſeveral employments and ſituations in the world, ſo as they tend to prove the evident interference of an all-good, all-wiſe, and omnipotent Being, in the creation and conduct of them.

Animal nature is diſtinguiſhed from every other part of the creation, by a certain principle of animation which pervades every atom of it, and as far as our *obſervation* extends, life can never be produced by, or reſult from any thing, but a living principle. Animals are therefore endued with an apparatus ſo refined and myſteriouſly ſubtile, as to communicate both matter and ſpirit in the continued ſpecies. The adage ſays, *Omne animal poſt coitum triſte*, and there certainly cannot be a doubt that in every act of propagation, a degree of life, ſpirit, animation, or whatever it may be called, paſſes from the cauſe to the effect.

Now the tendency in animals to propagate, or in other words, the deſire of the ſexes, ſuperſedes all other conſiderations. Hunger, cold, and fatigue, are endured without repining, when the gratification of this paſſion is the object; under its influence every ſpecies has continued undiminiſhed ſince the creation; and its univerſal prevalence is acknowledged by all animated nature.

As the young of a very large part of the creation would periſh, were they not produced at that ſeaſon of the year when the kindly warmth of the ſummer may cheriſh their infant ſtate, we ſee the wiſdom of the Almighty peculiarly manifeſted in ordaining, that the periodical returns of this paſſion ſhall be at ſuch times as are neceſſary to that end, and that it ſhall lie dormant at every other part of the year. Among thoſe creatures however whoſe hardy nature renders this reſtraint leſs neceſſary, ſuch as dogs, cats, and ſome others, its influence is more diffuſed.

In the human ſpecies it is ſtill leſs confined to ſtated times, becauſe reaſon teaches us the arts to correct the inclemencies of the ſeaſons, by moderating the extraordinary warmth of ſummer, and by ſupplying winter with artificial heat.

This paſſion with us too, is aſſociated with another, ſtrongly a-kin to it indeed, but much more intellectual and refined; and thus combined, tho' its ardor is not encreaſed by any periodical reſtraints, its empire over the mind is ſtill univerſal, and it has always been found the moſt powerful motive of human actions.—Among ruder nations its purſuit is indiſcriminate and unconfined; as civil ſociety prevails, laws are made to keep it within certain bounds, but are often made in vain; for we ſee that neither intereſt, ambition, the apprehenſions of danger, or the fear of infamy can reſtrain the illegal gratification of it.

Next to this is the ardent care and tenderneſs of animals for their offspring. This care is in ſome inſtances ſo exceſſive, that it ſeems to alter the nature of the animal on whom it operates; rendering the moſt ſlothful, active, and the moſt timid, fierce and ſavage. We cannot but remark too, how exactly the means are fitted to the end. There is no waſte of this care, no unneceſſary exertion of tenderneſs; for as its only end is protection, ſo in thoſe caſes where that is not wanted, it is not exerciſed at all, and where it is requiſite, is never extended beyond the time, when it ceaſes to be uſeful.

The offspring of almoſt every kind of viviparous animal requires the protection of the parents in their infant ſtate, tho' in very different degrees: Among oviparous ones, almoſt all kinds of birds require it likewiſe: Thoſe parts of the creation which do not, are chiefly crocodiles, ſome kinds of ſnakes, and almoſt every ſpecies of fiſhes, reptiles and inſects. Theſe in general depoſit their eggs or ſpawn, and then abandon them; the warmth of the ſun brings them forth; and as they are always depoſited in the nidus proper for their early exiſtence, they are immediately capable of taking care of themſelves.

I cannot omit this opportunity of remarking, that as of all creatures, the human offspring is the moſt helpleſs, and conſequently requires the greateſt and longeſt continued attention of the parents, ſo a mututal union and attachment ariſes from thence, which extends throughout life, and becomes the ſource of one of our higheſt intellectual enjoyments.

The next principle in nature to be conſidered is that univerſal and unremitting tendency to preſerve every ſpecies of animals diſtinct and apart from all others. In a few inſtances indeed, certain creatures are produced by the connection of two of a different ſpecies, but theſe mules are always barren, and incapable of further propagation; and thus the confuſion which would ariſe from a continuance of promiſcuous generation is effectually prevented.

It is alſo to be remarked that theſe unnatural connections (if the expreſſion may be allowed,) never take place but between different ſpecies of the ſame genus. Monſieur Buffon tells us, that a dog and a wolf will copulate and have young; a horſe and an aſs produce a mule; a canary bird and a goldfinch will breed together, and the reader will recollect other inſtances of a ſimilar nature.

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I muſt however caution him not to give credit to ſome idle ſtories, which travellers have very ſeriouſly aſſerted, of animals ſeen by them at Bruſſels, produced between a rabbit and a hen. It is true, a kind of fowl was exhibited there, covered with a ſubſtance more reſembling hair than feathers, and which, on the credit of that appearance, the keeper of the imperial Menagerie declared was the production of the two abovementioned creatures. Stories of this kind are too abſurd to be ſeriouſly combated, and are beſt anſwered by ridicule; as was once done by a gentleman, who, having heard ſeveral anecdotes of a ſimilar kind, related in a large company, declared that the moſt extraordinary connection he had ever been witneſs to, was between a magpye and a lobſter.

In conſidering the general principle before-mentioned, as applied to the vegetable kingdom, we ſhall find that as far as the different nature of animal and vegetable

getable life can admit of it, a ſtrong analogy is apparent in its mode of operation That the vital principle is conveyed from the plant to its product or ſeed is evident, becauſe the parent ſtock is always impoveriſhed and robbed of its vigour in proportion to the quantity of ſeed it produces, and is indeed by an extraordinary effort ſometimes entirely deſtroyed.

Naturaliſts have diſcovered that there are different ſexes in vegetables as well as in animals, and Providence has wiſely ordained that the male and the female bloſſoms ſhall almoſt in all inſtances be produced from the ſame plant.

The want of paſſions in vegetables is amply ſupplied by external cauſes, the operation of which is always ſufficiently regular and certain to produce the ends intended ; thus the farina of the male being a ſmall light powder is carried by the air, and impregnates the female bloſſom.

The want of active protection nature has fully compenſated, by incloſing the vital parts of ſeeds in large maſſes of matter of different conſiſtencies, which firſt protects and afterwards nouriſhes the plant in its infant ſtate.

The want of locomotive powers is made up, by a variety of moſt admirable contrivances, by means of which ſeeds are diſperſed. Some are ſpecifically light enough to be carried about by the wind; others more weighty are, by means of wings, rendered ſufficiently buoyant for that purpoſe; ſuch are the ſycamore, aſh, fir, thiſtle, and various others. Some either grow up under the parent plant, or becoming the food of different kinds of birds, and paſſing thro' the body uninjured, are thus diſperſed, and ſpring up where they happen to be depoſited*.—

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* Quails and Doves are frequently taken in Spain with ſeeds in their crops and ſtomachs, of African growth. Tavernier ſays that ſeveral birds, in the ſpice iſlands devour nutmegs, but from their heat are forced to throw them up again before they are digeſted. The Dutch prohibit the deſtruction of this bird, under pain of death, on account of its great utility in diſſeminating the ſpice trees.

Thoſe of a ſtill more weighty kind, ſuch as acorns, are plucked by rooks, pyes, &c. and carried by them into large fields and heaths, where they are buried with a view perhaps of being again returned to, but being either loſt or abandoned, ſpring up from the pit in which they had been hid †. The wiſdom of Providence is peculiarly ſtriking in this and ſimilar inſtances; for the ſize of the acorn is ſuch that the mere act of falling cannot ſufficiently immerſe it in the ground, for it to ſpring up with vigour, nor indeed would its vicinity to the parent ſtock admit of its arriving at any degree of perfection in that ſituation. The above proceſs therefore, in uninhabited places, is abſolutely neceſſary for the exiſtence of the ſpecies.

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† On a large heath much frequented by rooks, and where no oak trees were growing within a mile of it, I have obſerved, every ſpring, thouſands of plants juſt riſing from the acorns, which would doubtleſs arrive at maturity, were they not conſtantly deſtroyed by the cattle that graze there. Field-mice collect acorns and bury them for a winter ſtock. I have frequently found their hoards in the midſt of large fields.

We obſerve too in the vegetable as well as the animal kingdom, that nature ſeems to abhor all mixtures of the different ſpecies; for tho' by certain contrivances, ſuch as placing different plants very near to each other, the fruit of each will partake ſomething of the nature of its neighbour; yet the ſeed of theſe vitiated productions will, in two or three ſucceſſions, bring forth fruit perfectly pure and unmixed.

The next head which was propoſed to be conſidered, is the peculiar fitneſs and adaptation of the parts and properties of the animal and vegetable creation to their ſeveral employments and ſituations in the world, and the laws by which each ſpecies appears to be governed, ſo far as they tend to ſhew the agency of an all-wiſe and omnipotent Creator. The field is here ſo wide however, that man's underſtanding is too weak to diſcover, and his life too ſhort to deſcribe, all the inſtances of this wiſdom and power, with which every part of the creation abounds.

I ſhall therefore confine myſelf to a few of the moſt prominent and ſtriking particulars, which when pointed out will be immediately recogniſed, and will for that reaſon be moſt proper for the preſent purpoſe.

In conſidering the admirable formation of a bird, let us firſt advert to the ſhape and conſiſtence of its feathers. The two principal qualities requiſite are ſtrength and levity; and we can conceive no other means, by which theſe ends could have been ſo effectually accompliſhed. The quill is a tube extremely thin and hard, which form, being a continued arch, is the ſtrongeſt that any given quantity of matter can be thrown into. The ſhaft is the ſame kind of ſubſtance, not quite ſo hard, filled with a very light ſpongy matter, tapering gently towards the point and arched only on the upper ſide, becauſe the feather may bend only downward, and may be enabled to bear the reſiſtance of the air as the bird flies. The vanes of each feather are compoſed of a number of fibres furniſhed with ſmall hooks, by means of which they adhere to each other, and, if ruffled, are eaſily adjuſted: whereas had they been membranous and ſufficiently light, the leaſt accident would have injured them irreparably; and if thick enough to have had the neceſſary degree of ſtrength, would have been inſufferably heavy.

The only animal furniſhed with wings of this kind is the bat, and there the propriety of them is peculiarly conſpicuous; for as it has neither a bill nor a long neck, any defects in a wing of feathers could never have been adjuſted; and for the ſedentary life and ſhort flights of that animal, its membranous ones are quite ſufficient.

The general formation of the whole body of a bird is not leſs to be admired than that of each feather. The wings when extended are arched above, becauſe the air may ſlide over them in the act of elevation, and becauſe in that of depreſſion they may give ſuch a reſiſtance as to ſuſpend the bird upon it. In the next place they are ſo ſet on to the body that its centre of gravity is much below as well as behind the line of ſuſpenſion, which produces a ſteadineſs both in its paſſage thro' the air, and alſo when nearly ſtill, as in ſoaring.

As vaſt ſtrength is requiſite in the wings, the muſcles by which they are worked form the greateſt part of the body, and are ſo admirably contrived, that the ſame ſhape which gives them the moſt poſſible ſtrength, is the moſt perfect for the bird's paſſage thro' the air.

The tail is compoſed of a few feathers with large wide vanes, which ſerve to keep the bird ſteady in its flight, and by the ſlighteſt motion of which its courſe is altered.

All the feathers are ſo placed as to give the leaſt poſſible reſiſtance to the bird's flight, and to defend it in the moſt effectual manner from the inclemencies of the weather; and for their further ſecurity from moiſture, any great degree of which would for a time impede the uſe of them, the rump of every bird is furniſhed with two glands and an excretory veſſel, from whence with its bill an unctuous matter is expreſſed, with which the feathers are occaſionally anointed, and are by this means capable of ſuſtaining a long-continued rain without injury.

The above obſervations apply, with little variation to birds in general: Let us now advert to thoſe particulars, in which the various ſpecies differ from each other.

Thoſe which live altogether on ſmall beetles caught in the air, ſuch as the ſwallow tribe, as their flight muſt be almoſt conſtant, and they have little occaſion for walking, have long wings, ſhort legs, and very wide mouths.

Thoſe which feed promiſcuouſly on inſects, ſmall reptiles, berries, &c. ſuch as thruſhes, redſtarts, red-breaſts, wrens, hedge-ſparrows, black-caps, and a variety of others, have wings, legs, and mouths, of a moderate ſize, having occaſion to ſearch the earth as well as the air in purſuit of their food.

Thoſe kinds which are almoſt or altogether granivorous, ſuch as tame land fowls, partridges, pheaſants, finches, &c. have ſhort wings, ſtrong legs, and ſhort, ſtrong, hard bills.

Woodpeckers have a formation peculiar to themſelves, as different from all other birds as their mode of living is. They feed chiefly on thoſe inſects, which inhabit between the bark and body of decayed trees, and their apparatus for getting at them is extremely curious. Their bills are conical, long and ſharp at the point; their tongues ſo long that they can occaſionally thruſt them ſeveral inches without their mouths. Their legs are ſhort, and their feet placed two before, and two behind. The feathers of their tails are remarkably ſtiff, and the quill at the point projects beyond the vanes. When a tree is found likely to yield them food, the formation of the claws enables them to climb up the trunk and limbs of it with facility, where being ſupported by the ſtiff tail, they by repeated ſtrokes of the bill, bore a hole in the bark, and introducing their long tongues (the tops of which are armed with a number of ſmall points for that purpoſe) draw forth their prey*.

Birds of prey, ſuch as eagles, vultures, kites, buzzards, falcons, and hawks, have ſeveral characteriſtic marks. Their claws are remarkably large, ſtrong, and crooked, and therefore peculiarly fitted for ſeizing and retaining their prey; Their beaks are very ſtrong and the upper mandible projecting beyond the lower, is arched and ends in a very ſharp point, by which its food is torn, and properly prepared for the ſtomach. But the mark, which moſt ſtrongly diſtinguiſhes this claſs of birds from all others, is a very conſiderable projection of the bone of the ſcull over the eyes; for as they ſoar aloft in the air, and generally look downward for their prey, the dazzling of the ſunbeams would impede their ſight, were not their eyes defended by the means above-mentioned†.

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* I was informed by the excellent naturaliſt to whom this trifle is dedicated, that he was once a witneſs to a curious inſtance of diſappointment in one of theſe birds. Having diſcovered a tree which was hollow near the ground, and alſo at ſome diſtance above it, the woodpecker appeared to him to have inferred, reaſonably enough, that it was decayed alſo between the both, and therefore attacked that part; but after much labour and perſeverance having penetrated through the bark, which being ſound, was attended with an unuſual difficulty, it found out the miſtake, and flew off with much clamour and apparent indignation.

The claws and beaks of nocturnal birds of prey are much like the former, but their heads and eyes are totally different. Thoſe of the owl afford a ſtriking proof of the wiſe deſigns of Providence. As the prey of this ſpecies conſiſts of ſuch

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† It is from this projection over the eyes of birds of prey, that their peculiar expreſſion of anger or fierceneſs ſeems to be derived: for it will be recollected, that the ſame form produces that character in the hu-

ſmall animals as roam chiefly in the evening and night, every ray of light that can be collected is neceſſary to their diſcovering it; their eyes are therefore extremely large, and the pupils occupy a very conſiderable part of them; they are alſo fixed in the head, and not moveable independent of it, as in all other birds; for were the eyes moveable, part of the pupil would be obſcured by the lids, and of courſe ſome light be loſt upon every oblique direction of them. That no defect may attend this want of motion in the eyes, they are endued with a latitude of the neck, which enables them to turn their heads quite round, and by this curious contrivance their powers of viſion are as compleat, as the ſmall degree of light in which they uſe it will admit of*. Leſt a want

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man face. A full eye-brow and a projection of the forehead at that part, gives a determined appearance to the countenance; and indeed the paſſion of anger is expreſſed by ſuch a contraction of the eye-brows and muſcles of the forehead, as produces exactly that ſhape.

* A gentleman of my acquaintance, having two horned owls in a cage, was greatly ſurprized one morn-

want of light however ſhould ſtill be a ſufficient bar to their obtaining their food, they are provided with ears of a moſt immoderate and diſproportionate ſize, and thus the defects of viſion are ſupplied by a moſt acute ſenſe of hearing. But as owls for the moſt part are ſedentary and ſleeping by day, and as at that time their large ears would not only be uſeleſs, but inconvenient to them; they are covered with large valves compoſed of thin films ſtrongly matted with feathers, which can be elevated or depreſſed at pleaſure, and which form a ſufficient defence againſt the noiſe and clamour that may ſurround their retreats.

The croſs-bill, whoſe food conſiſts chiefly of the ſeeds of the fir tree, would be unable to get at them with a beak of

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ing at obſerving that they had both changed colour during the night: The fact was, that they ſtood with their backs and their faces both towards him. However, while he was conſidering this extraordinary phænomenon, the myſtery was unravelled, by one of them turning round its head.

the common form, and is therefore provided with one of a conſtruction admirably adapted to that purpoſe, and different from that of all other birds. The two mandibles croſs each other at the point, are extremely ſharp and of a very ſtrong horny ſubſtance; its neck is very ſhort and thick, as are alſo its legs and feet: by means of this apparatus the lamina of the cones are eaſily wrenched open and the ſeeds obtained.

The next claſs of birds to be conſidered is that of the waders, whoſe food is principally aquatic reptiles, and ſuch fiſhes as inhabit ſhallow waters; theſe are diſtinguiſhed by very long legs and necks, and by bills of a ſtrong ſharp form, indented or ſerrated for the purpoſe of retaining their ſlippery prey: It is alſo aſſerted that when they ſtand in the water, the fiſh are attracted by an agreeable ſcent in their legs, and thus become an eaſy conqueſt. Of this kind are the flamingo, the ſtork, the various cranes, or herons, &c.

The next are thoſe which live on aquatic inſects, and ſmall earth-worms, ſuch as curlews, godwits, tringæ, woodcocks, ſnipes, and various others; theſe have necks and legs of a moderate length, but very long ſlender bills, with which the ooze and moiſt earth is eaſily perforated, and their food extracted.

I muſt not omit to mention the avoſetta, which partakes of the properties of both the laſt claſſes, having very long legs, neck, and bill, the latter of which is very ſlender, compreſſed and reflected upwards at the point, in which it differs from that of all other birds. Its food conſiſts of thoſe ſmall aquatic inſects which are found under ſtones both in the ſhallow water, and on the weed, and which it could only be enabled to procure by this remarkable formation of its bill.

Water fowls, properly ſo called, have generally ſhort legs, necks, and wings; their feet either whole or half webb'd, their bodies long and flat, and their legs placed far behind. As this particular ſhape and diſpoſition of the parts is peculiarly proper for their paſſage through the water, we find it carried to the greateſt extreme in thoſe kinds which generally ſwim and dive, and ſeldom walk or fly; ſuch are penguins, loons, cormorants, razor bills, guillemots, dob-chicks, &c. The legs of theſe are placed ſo far back that when on their feet, their bodies are almoſt erect, and they walk with the greateſt difficulty. Their wings are ſo ſhort, particularly thoſe of the dob-chick, and penguin, that the former ſeldom, and the latter never flies at all: but as all theſe ſubſiſt on fiſh, which they catch by diving, theſe ſeeming deficiencies conſtitute the perfection of their ſhape. The formation of the foot is ſuch, that tho' in its extended ſtate, and when a ſtroke is given, a large ſurface is oppoſed to the water, yet when gathered up, a mere edge is preſented to it, and from its ſituation in the the hind part of the body it not only does not impede the paſſage of the bird, but being thrown back behind the tail, ſerves as a rudder to direct it. The wings, which if long would be in the way when the bird dives, are now of the greateſt benefit, being uſed in the ſame manner, and for the ſame purpoſe that the ſhoulder fins of a fiſh are.

Thoſe water fowls which feed on grain and water inſects, ſuch as ſwans, geeſe, ducks, widgeon, &c. have ſuch a form and relative ſituation of their parts, as renders them fit in the higheſt poſſible degree for their various purſuits; thus tho' their legs are ſo placed and their wings are ſo long, that they cannot ſwim and dive with the facility of thoſe laſt deſcribed, yet they can walk and fly much better.

The tribe of gulls whoſe food conſiſts of various ſubſtances which float on the water, or of fiſh that ſwim near the ſurface of it, have very long wings, light bodies, and webbed feet; thus they are enabled to fly far and long in ſearch of their prey, to dart on it with ſufficient velocity when diſcovered, and to reſt on the ſea when fatigued in the purſuit.

I may add to what has been ſaid of water birds, that their feathers are ſhorter and more compact than thoſe of land fowl, and that they are furniſhed with a larger proportion of the unctuous matter before mentioned, the effect of which is that the feathers of ſuch as have been many days together in the water are perfectly dry and unaffected by it.

All kinds of birds are endued with an ample power of diſtinguiſhing their proper food, and in general the eye is ſufficiently accurate for this purpoſe. Should that monitor however be deceived, which does ſometimes happen, their ſenſe of taſte or feeling is ſo perfect, that any improper ſubſtance is rejected the moment it enters the point of the bill.

It is obſerved, that the claſs above mentioned with long bills, have a more than ordinary ſhare of this exquiſite taſte or feeling, becauſe the eye can give them no aſſiſtance in their mode of procuring their food, particularly as from the ſmallneſs and ſcantineſs of it, moſt of them are obliged to feed by night as well as by day. This nice power of diſcrimination, is therefore abſolutely neceſſary to their exiſtence.

All granivorous birds, and ſome others are furniſhed with a membranous bag called a crop which hangs before and without the cavity of the body. This ſerves as a reſervoir for a larger quantity of food than they can uſe at any one time; by which two ends are anſwered. Firſt, they are provided with a little ſtore, againſt thoſe emergencies when the inclemency of the weather prevents their going in queſt of it; and ſecondly, they can at their pleaſure take a ſmall part of it into their ſtomachs, which in thoſe kinds of birds are called gizzards. Now as birds have no teeth to maſticate their food, that of granivorous ones would paſs through their bodies without yielding any nouriſhment, were not thoſe gizzards ſo curiouſly conſtructed as to ſupply this deficiency. They conſiſt of a ſtrong, muſcular ſubſtance, lined with a hard furowed membrane, by the attrition of which, aided by ſmall angular ſtones or pebbles taken into it for that purpoſe, the grain is ſufficiently levigated. Many birds have alſo a kind of ante-ſtomach, called echinus, which is nothing more than an extenſion of the gut immediately before the gizzard, and which being full of glandular excreſcencies diſtilling a ſoft oily matter, aſſiſts in changing the levigated grain into chyle.

Thoſe birds which never feed on hard ſubſtances, ſuch as rapacious land birds, and ſome piſcivorous ones, have no muſcular ſtomachs or gizzards, becauſe the nature of their food is ſuch as not to require the abovementioned proceſs, and it is generally torn into ſmall pieces before it is ſwallowed.

As thoſe birds which reſt chiefly on the ground are expoſed to the attacks of more enemies than ſuch as perch or are generally on the wing, the great care and wiſdom of Providence is ſtrongly manifeſted in having ordained that their colour ſhall be ſo ſtrongly allied to that of the places of their reſpective reſort, as to be diſtinguiſhed from it with the utmoſt difficulty. Thus the back of a woodcock is like a mixture of dead ſticks, leaves, and earth; that of a ſnipe, like green and dried ruſhes; of a lark, like earth, ſtraw and graſs, and the ſame of many others: and as nature has furniſhed them with this mode of concealment, it has evidently inſpired them with a conſciouſneſs of, and dependency upon it, for we ſee that thoſe above mentioned will remain undiſturbed till they are in danger of being trampled upon.

Dr. Moore has very juſtly obſerved on the neceſſity of birds being oviparous and not viviparous; for had the latter been the caſe, their flight would have been ſo impeded during the time of geſtation, that they muſt have fallen a prey to their numerous enemies.

Mr. Ray too remarks on the curious means by which young birds are ſupplied with their proper nouriſhment in their infant ſtate. Were they, at their excluſion from the egg, to paſs from a liquid to a hard and ſolid diet all at once, before the ſtomach was properly conſolidated, and by uſe ſtrengthened to grind and concoct it, they could not ſurvive ſuch a change; nature has therefore provided a large yolk, a great part of which, after the chicken is hatched, remains incloſed in its belly, and through a channel made on purpoſe is received by degrees into the inteſtines, and ſerves inſtead of milk to nouriſh it, till it obtains ſufficient ſtrength to digeſt ſuch ſolid food as is proper to its ſpecies.

He alſo obſerves on that admirable and neceſſary inſtinct by which birds ſo diſtinguiſh their young as to feed them all equally; for although in moſt caſes one morſel only is brought at each return of the dam, and all the neſtlings gape for it with equal greedineſs, yet all receive it in turn, and not one is neglected.

Their neſts too, are not leſs worthy of our obſervation, as to the ſtated periods at which they are built, the form in which they are conſtructed, and the ſituations in which they are placed. They are always built at a time previous to that in which the birds begin to lay their eggs, and in this the male is equally buſy with the female; the ſame kinds of birds always make neſts of ſimilar conſtructions and materials, and in ſimilar ſituations; to which may be added, that if the ſituations are low and within reach, the neſts are always ſecret and obſcure, and that they are never conſpicuous but when high and at a diſtance.

The oſtrich and perhaps the caſſowary or emeu, differ from all other birds in that they never ſit on their eggs, or even make a neſt, unleſs the dry ſand in which they depoſit them may be called ſo. And here again we ſee the wiſdom and evident deſign of Providence, in ordaining that theſe birds ſhall inhabit thoſe dry burning deſerts, where the heat of the ſun may ſupply the place of incubation, for which the enormous length and ſize of theſe bird's legs render them totally unfit.—Their young too are the only ones which are capable of ſuccouring and providing for themſelves in their infant ſtate; for altho' many other kinds have the uſe of their legs and a capacity of feeding themſelves immediately on their excluſion, yet the foſtering of their dams by night, or ſome better ſubſtitute for it than chance can ſupply, is abſolutely neceſſary to their preſervation.

I ſhall only add one inſtance more in which the general mode is materially deviated from, and that is in the caſe of the flamingo, whoſe long legs render it impoſſible for her to ſit in a neſt of the common form, and which, being neceſſarily a frequenter and inhabitant of pools, lakes, and ſea-coaſts, and the young ones requiring her aſſiſtance, cannot avail herſelf of the expedient laſt deſcribed. This bird therefore, as we are told by Dampier, raiſes little hillocks from the bottom of ſhallow waters to a certain height above the ſurface, on the top of which the neſt is made, and the eggs are depoſited; ſhe then ſtands in the water againſt the hillock, and reſting her body on the eggs, in that uneaſy poſture patiently waits the event.

I ſhall conclude this ſubject of birds, with remarking, that the legs and feet of thoſe that perch are ſo admirably conſtructed, that the mere ſuperincumbent weight of the body, and the conſequent bending of the legs, ſo contracts the tendons of the feet as to make them claſp the bows on which they ſtand; whereas had a muſcular exertion been neceſſary for this purpoſe, a conſtant fatigue would have attended it, and during the relaxation and inattention of ſleep, they muſt frequently drop from their rooſts.

Having adverted to ſo many proofs of the curious formation and properties of birds, it will be leſs neceſſary to go ſo widely into other parts of the creation, tho' they all equally tend to ſhew that not chance, but conſummate wiſdom and almighty power could alone have produced them.

In the formation of beaſts too, we muſt obſerve that there is no incongruity, but that all the parts of each conform, in the moſt perfect manner, to its ſituation and mode of life.

Among dogs, the hound is endued with a keen ſcent, great ſtrength, and indefatigable perſeverance; all which qualities are neceſſary in the purſuit of its food. The terrier, whoſe prey is ſavage, and ſecretes itſelf in holes and caverns under the earth, has ſhort legs, and extreme courage and ferocity. The greyhound, which has no ſcent to direct it, is admirably formed to take its prey while in ſight, having a quick penetrating eye, a ſharp front to divide the air in its purſuit, a light body, and very long muſcular and tendinous legs and thighs. Carnivorous animals have ſharp teeth and claws, and ſtrong ſhort necks; herbivorous ones have necks always proportioned to the length of their legs, ſo as that they may eaſily reach the ground; but as holding their heads in this inclined poſture for a conſiderable time together would be extremely painful and laborious for the muſcles, theſe animals are provided with two ſtrong ligaments of great ſtrength and thickneſs, which ſtretch and ſhrink occaſionally, and extend one on each ſide of the vertebræ, from the head to the middle of the back, and being faſtened at each end, ſupport the head without any muſcular exertion. The teeth of this kind are ſharp before, to divide the graſs from the ground, and flat behind, for the purpoſe of maſticating ſo ſmall a ſubſtance. Thoſe kinds which live chiefly on roots, ſuch as hogs, badgers, &c. have keen ſcents to direct their ſearch, and long ſharp noſes, to turn up the earth in queſt of their food,

It has often been remarked that the eyes of all animals are ſo reſpectively ſituated, that thoſe which are purſued have a latitude of ſeeing their enemies in the rear; as hares, rabbits, &c. while thoſe of beaſts of prey, are ſet ſo forward in the head, that they may ſee chiefly before them, as dogs, cats, wolves, tygers, lions, &c.

The formation and ſituation of the ears are evidently deſigned with a view to the ſame end; thoſe of the former animals having the cavities ſo placed as to catch ſounds from behind, and of the latter ſo as to hear beſt before them.

As the ſtrong and crafty animals are ever preying on the weak and ſimple, every one is furniſhed with ſome mode of defence peculiar to itſelf. With the greateſt number it conſiſts of an active offence of their adverſaries; thoſe kinds have horns, teeth, claws, hoofs, and various other weapons allotted them. Others offend their enemies in a leſs active manner, either by their obnoxious appearance, by emitting diſagreeable ſcents, by hideous noiſes, or by involving themſelves in a prickly coat like the hedge-hog; and others again owe their ſafety to flight, to concealment, or to impenetrable coats of mail, like the tortoiſe, armadillo, houſe-ſnail, &c.

It may here perhaps be urged that as Providence deſigned ſome animals for the food of others, it is no proof of its wiſdom that difficulties ſhould be thrown in the way of the purſuer. To this I ſhall anſwer, that as voracious animals have always ſome difficulty in taking their prey, and the latter have always a chance of eſcaping by ſome of the modes of defence above mentioned, it is very juſt and reaſonable to conclude, that ſo general a ſyſtem does not prevail, without ſome wiſe intention in the Creator being anſwered by it. In the firſt place it certainly prevents any wanton and unneceſſary deſtruction of the weaker animals; and in the next it is moſt probably attended with conſiderable advantage to thoſe which devour them; for as all carnivorous and piſcivorous creatures are obſerved to be more heavy and ſluggiſh than any others, during the intervals of their rage for food, perhaps this very difficulty and uncertainty of obtaining it may induce ſuch an activity and exerciſe in the purſuit, as is abſolutely neceſſary to their health and exiſtence.

The covering of animals is proportioned and adapted to the reſpective climates in which they exiſt: in warm countries their hair is generally light and thin, in cold ones thick and ſtrongly connected; in the latter too, animals, particularly amphibious ones, are involved in a thick covering of fat, which prevents the ſtrong action of the cold upon the nerves, and without which defence they could not exiſt amidſt the everlaſting froſts and ſnows of the high northern and ſouthern latitudes.

The heat of a climate, which renders a cool covering neceſſary to the animals reſiding in it, is the very means of its becoming ſo, and cold has the oppoſite effect: thus the wool of ſheep is ſoon converted into hair on their removal into a warmer country, and thoſe which have hair in their native ſoil, are ſoon cloathed with wool on being carried into a colder one. It has been before remarked, that the colour of ſuch creatures as reſt chiefly on the ground, agrees with that of the places of their reſpective reſort; and in thoſe countries which are covered with ſnow in the winter ſeaſon, nature ſtill produces this conformity, by cloathing them in white during that period.

I ſhall now briefly advert to the beauty, variety, and formation of fiſhes, which tho' leſs ſubject to our notice and inveſtigation than the other parts of the creation, are ſtill ſufficiently known to excite in us the ſtrongeſt admiration and acknowledgement of an almighty power and wiſdom.

Their variety is perhaps equal to that of all the other parts of the creation together (except inſects) and indeed poſſibly ſuperior to them, as we may reaſonably conclude that vaſt numbers yet remain undiſcovered and unknown.

Of thoſe that are known, the whale is the largeſt of which we have any certain accounts, and the next is perhaps the ſhark: as theſe are both fiſhes of prey, it may not be amiſs to examine the different apparatus of each, and how admirably they are fitted for their reſpective purpoſes and purſuits. That of the whale conſiſts of fiſhes ſo ſmall in proportion to its immenſe bulk, as to require no maſtication, but of which ſo large a number are neceſſary to feed it, as would make endleſs work were they to be taken in ſingly. This creature therefore has no teeth, but its mouth is lined with a number of filaments like coarſe hair, by means of which when a quantity of ſmall fiſh are taken within the jaws, they are entangled and retained, while the water is ſtrained off and diſcharged.

The ſhark, on the other hand, whoſe food conſiſts of much larger fiſh, and indeed of every creature, almoſt, that comes in its way, is provided with ſeveral rows of ſharp teeth ſtanding in different directions, with which its prey is ſeized and mangled into a ſtate fit for the ſtomach. It is remarked of this fiſh, that being not only the moſt voracious, but alſo the quickeſt ſwimmer of all the inhabitants of the ocean, nothing could eſcape its purſuit had not providence wiſely thrown one impediment in the way, by placing the mouth ſo far under the head, that it is obliged to turn on its back, before its prey can be ſeized; by which ſo much time is loſt, that many creatures eſcape, which muſt otherwiſe fall a ſacrifice to it.

The ſhape of fiſhes is the moſt proper that can be conceived for their paſſage through the water; in general their fronts are ſharp, that part of the body which is juſt before the middle, thickeſt, and from thence tapering gently to the tail, to which, as moſt ſtrength is requiſite, ſo the largeſt portion of muſcle is allotted. The fins are for the moſt part ſo contrived, as to open and ſhut, not unlike a fan, for the purpoſe of giving a ſtroke to the water, and of being ſuddenly cloſed ſo as not to impede its paſſage.

Fiſhes in general are furniſhed with an air bladder, which, by means of a muſcle attached to it, they can at pleaſure either dilate or contract, and thus render themſelves more or leſs buoyant, as they want to aſcend or deſcend in the water, or as their bodies become more or leſs heavy by repletion, evacuation, or during geſtation. Flat fiſh however, and other grovellers, have no air bladders, becauſe their ſituations require that their ſpecific gravity ſhould always exceed that of the water.

The œconomy and properties of inſects and reptiles are equally wonderful and admirable with every other part of the creation, and their vaſt variety ſtill remains unknown.

The limits which I have preſcribed to this eſſay will not permit me to enlarge much on this part of the ſubject, and indeed the inſtances of the power and wiſdom of the almighty already adduced, have, I truſt, rendered it unneceſſary to my preſent purpoſe. I ſhall however make ſome ſhort obſervations on both theſe claſſes, and point out a few of their reſpective qualities and perfections.

Under the name of reptiles are generally comprized all ſuch creatures as crawl, either with or without legs, ſuch as lizards, ſnakes, worms, &c. and alſo the nymph or vermicular ſtate of inſects, ſuch as caterpillars, maggots, grubs, &c.

The curious mechaniſm by which the want of legs is ſupplied in ſerpents, well deſerves our notice. Their progreſs is effected by that particular motion and curvature of the body, which from them is called ſerpentine; aided by the peculiar conſtruction of the ſcales of the belly, which, contrary to thoſe on the other parts of the body, are ſet in parallel lines at right angles to it. Each of theſe ſcales has its ſeparate muſcle, by which its edge is a little elevated, ſo as to bear againſt the ground, and prevent the body from ſliding backward.

The earth worm is furniſhed with one ſpiral muſcle, running round it, from head to tail, to which are annexed a number of ſmall points, which it can either emit or withdraw at pleaſure; by this moſt admirable and ſimple contrivance,

vance, it is enabled to move either backward or forward, with equal facility; for by extending the muſcle at one end, and thruſting out the little points from that part only, the other muſt neceſſarily follow it, when the muſcle is again contracted. When we advert to the habitations which this creature makes for itſelf in the earth, we ſhall obſerve that two neceſſary ends are anſwered by this curious apparatus: In the firſt place the rotary motion, which it can aſſume occaſionally, is moſt proper for boring its way into the ground; and in the ſecond, as the hole thus made is but little larger than its own body, the worm could never extricate itſelf, but by its retrograde power.

By inſects are underſtood that perfect and winged ſtate of thoſe creatures which generally appear under three different forms after their excluſion from the egg. In their firſt or nymph ſtate, they appear in the ſpring and ſummer, when they eat voraciouſly, grow faſt, and ſoon arrive at their full ſize; as the winter approaches, impelled by a neceſſary inſtinct, they retire to the various hiding places which are reſpectively proper for them, and there enter into their ſecond or aurelia ſtate; this is generally a hard caſe or kind of ſecond egg, in which they remain almoſt lifeleſs and motionleſs till the return of the warm weather, when they are, as it were, regenerate, and appear in their perfect or winged ſtate.

Nothing can be more diametrically oppoſite to each other, than the nature and appearance of theſe creatures in their different ſtates. In the firſt, almoſt every ſubſtance and every plant has a ſpecies to which it yields habitation and nouriſhment; ſome are pent up in fruit, in kernels, in excreſcences of vegetables, and various other things; ſome roam from place to place, and devour as they go; ſome exiſt on living creatures, others on putrid fleſh. In the ſecond ſtate, their life ſeems ſuſpended, they neither eat, move, or increaſe in bulk; but in the laſt they appear as the gayeſt and moſt beautiful part of the creation, in all the variety of form and colour, and their former confinement ſeems to be compenſated by a life of love and pleaſure; for in this ſtate their principal buſineſs is propagation. After that is over, and as winter approaches, moſt of them periſh; ſome, however, ſurvive the following winter in a kind of torpid ſtate, having ſought out various places of concealment; and ſome few provide themſelves with a ſtore of food during the ſummer months, to laſt them through the winter. The chief of theſe is the bee, whoſe ſkill and induſtry, altho' ſo much has frequently been ſaid on it, muſt not here be paſſed by unnoticed.

In the actions of this little creature, we cannot but acknowledge the agency of a wiſe ſuperintending power. Inſtinct teaches animals in general to ſeek food when hunger calls on them, and to reſt from their ſearch when that is ſatisfied: but here we ſee indefatigable pains and induſtry employed in collecting and laying up a ſtore of food for purpoſes, which cannot be foreſeen at the time it is performed. The curious geometrical conſtruction of the combs too is equally admirable, being exactly of that form and ſhape, which afford the greateſt poſſible ſtrength and ſpace united; for, had the cells been circles, triangles, ſquares, octagons, or any other ſhape but what they are, ſome room would have been loſt in the ſpaces and angles which muſt have occurred, either in, or between each; but in the hexagonal ſhape of them, there is no waſte whatever, every ſide forming a ſixth part of two cells; and as the combs are double with a kind of partition wall between them, the whole is ſtrengthened by the angle which connects the cells on one ſide reſting againſt the centre of a cell on the oppoſite one. Were theſe interſtices however uſed only to contain honey, a ſquare or triangular form would perhaps have done as well, becauſe neither would have had any intermediate ſpaces, and that liquid matter would have eaſily ran into the angles; but as theſe cells are alſo the receptacles of the young bees in the two firſt ſtates of their exiſtence, the hexagonal form only could contain ſo large a number in any given ſpace.

In conſidering the nature and properties of vegetables, we cannot but acknowledge the evident deſign and wiſdom of the Creator, in ordaining that thoſe which are of the moſt general uſe, are moſt widely diſſeminated; thus graſs abounds in every part of the earth; and Mr. Ray obſerves that wheat, which is the moſt uſeful of all plants for the food of man, is patient of the extremes of heat and cold, and is produced in every country where its cultivation has been attempted. It is alſo remarked that medicinal plants are obſerved to flouriſh in thoſe places, where the diſorders which they are applied to cure, chiefly prevail: and a great botaniſt has declared, that by inſpecting the plants of a country, he will immediately diſcover to what diſorders the inhabitants are principally ſubject.

In the various formation of plants too, wiſdom and deſign are equally evident. Such as have weak ſtems, are ſupplied with the means of obtaining the aſſiſtance of thoſe which have ſtrong ones: ſome have a tendency to twine round whatever comes within their reach, others have claws and tendrils, by which they affix themſelves to various ſubſtances; ſome ſpread their lofty heads, and ſome grow retired beneath their ſhades: various kinds are creeping on the ground; the bottom of the ſea, of pools and rivers produces ſome, and others grow on the ſurfaces of each. Thus all nature abounds with vegetable as well as animal productions.

The various means by which the ſeeds of plants are diſſeminated, have been already adverted to, and I ſhall only add, that the ſeeds of thoſe kinds, which grow on the bark of trees, on walls, the roofs of houſes, high rocks, &c. are generally ſo ſmall, particularly thoſe of the various moſſes, that ſome of them are inviſible, and others appear only as a fine powder; ordained doubtleſs for their ready conveyance to the places proper for their vegetation.

It may not be amiſs to add that altho' culture and good management will enlarge ſome plants to two, three, four, and perhaps ten times their uſual bulk, yet this is always within certain limits, and proportions, the root always keeping pace with the head, and ever varying in degree only and not in kind; for no art or managment can ever make the ſeed of one plant produce a kind materially different from its parent, otherwiſe than that mixture before alluded to.* There is in the ſeed of each that vital principle, by which its ſpecies is continued unchanged through conſtant ſucceſſions, by which it draws from the earth that nutriment which is proper to itſelf, and from whence it receives its peculiar ſhape, colour, and individuality.

Having thus given numerous inſtances of the general conformation of the parts of animals reſpectively to one common end, and of the perfect fitneſs and adaption of each, to its particular purſuit and ſituation; it may perhaps be urged that this is no proof of divine wiſdom, becauſe, if all creatures were produced by chance, they would of courſe apply the faculties, and powers which they happened to poſſeſs, to thoſe purpoſes and purſuits for which they were moſt fitted. This objection would have ſome weight, if it was found that animals diſcovered

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* See page 54.

covered the uſe of their talents only from experience: but the contrary of this is notoriouſly the caſe; for we ſee various inſtances of a propenſity in young animals to actions proper for their mature ſtate, before they have any efficient poſſeſſion of the powers, or weapons which render them neceſſary. Thus the play of young kittens is an imitation of thoſe actions, which are afterwards uſed in the purſuit and capture of their prey. Calves, lambs, kids, &c. will butt with their foreheads, before their horns begin to appear. That this does not ariſe from imitation is clearly demonſtrable; for had that been ſo, the young of one creature would conſtantly imitate the actions of any others that it happened to be aſſociated with in its infancy; which is by no means the caſe.

Another proof of an original and inſtinctive influence is, that we conſtantly perceive a uniformity in the actions and manners of the ſame ſpecies, as to things which do not neceſſarily ariſe from their reſpective formations. Thus every bird builds a neſt peculiar to its own ſpecies, as to form, ſituation and materials, and different from that of every other. That all web-footed birds ſhould ſwim, does not ſeem ſo very extraordinary, becauſe they all agree in thoſe parts which are neceſſary to that operation; but that various ſpecies equally ſimilar in the conſtruction of their bodies with thoſe, ſhould conſtantly build different neſts, muſt ariſe from an influence perfectly foreign and extrinſick, and which cannot be derived from imitation or precept, becauſe moſt birds are in pairs at thoſe ſeaſons, and can therefore have neither precedents or inſtructions to direct them.

Another circumſtance to this purpoſe is, that early mode of intelligence by which animals render themſelves underſtood by their young. Their language is not like ours, acquired by ſlow degrees, but is apprehended inſtinctively, at a very early period indeed. The cluck of a hen will call the chicken about her at their firſt wandering from her ſide. The language of each ſpecies however, is only underſtood by its own kind, or at leaſt can be comprehended in a very ſlender degree by thoſe of another; and that from experience only, and not by inſtinct: thus when ducks are hatched under a hen, 'tis long before ſhe can make them underſtand her call, and if once they diſcover their favourite element, no efforts of her's can reclaim them from it.

The effect of this very early intelligence of the language of their dams, is in no inſtance ſo ſtrongly viſible, as when uſed for a warning of danger. I have ſeen young turkies, the day after they were hatched, crouch down and hide themſelves in the graſs, or fly with precipitation to the neareſt ſhelter, at a certain plaintive voice of their dam, which denoted the approach of a bird of prey;

and which, by the bye, they have a power of diſcerning at an almoſt incredible height in the air.

I ſhall cloſe theſe obſervations on the early inſtinct of animals, with a ſtory which Mr. Ray has quoted from Galen, the truth of which is I believe undeniable, and the inference unanſwerable.

"Having cut out a kid from the belly of its dam, he inſtantly carried it into a room, where various veſſels were ranged around, filled ſeverally with wine, honey, oil, milk, and other liquors; and ſome alſo with different ſorts of grain and fruit. The kid ſoon got on its legs, and preſently began to ſcratch its ſide in the manner of goats, with its foot, and having ſmelt to the ſeveral ſubſtances around it, at laſt ſupped up the milk. In two months the ſprouts of various plants were brought to it, when having ſmelt to all and taſted ſome few, it continued to eat thoſe, which are the uſual food of goats; and ſoon after ſwallowing them, again brought them up and chewed the cud. During all this time the kid had never ſeen its dam or any of its ſpecies.'

As it was my intention not only to point out the fallacy of thoſe particular inſtances which the author has adduced in ſupport of his notions of ſpontaneous generation, but alſo to make ſome remarks on that doctrine in general, it will be neceſſary firſt to conſider what it amounts to when carried to its utmoſt extent, and what is the Hypotheſis on which it is founded.

Its tendency, as has been before remarked, is abſolute atheiſm; or at leaſt, a denial of the agency of a ſupreme being in the creation of the world; and the hypotheſis of its advocates is, " That out of millions of creatures and things accidentally produced by the heat of the ſun, fermentation, putrefaction, &c. thoſe only ſurvived and continued their ſpecies which happened to be formed ſufficiently perfect for that purpoſe, and that the vaſt numbers of incomplete ones periſhed."

This abſurd ſyſtem has been combated by various writers, and among others, very effectually by Dr. Moore, Dr. Bentley, Mr. Ray, and Dr. Derham. I ſhall mention a few of their moſt ſtriking arguments, with ſuch others as may occur.

In the firſt place, had all creatures been produced by chance, great numbers muſt have been ſufficiently compleat to have exiſted and continued their ſpecies, without that extreme degree of perfection, and that exact concurrence and conformity of the parts of each to one common end, which, we know, univerſally obtains. Among animals, for inſtance, two eyes, two ears, two noſtrils, or the regular diſtribution of them in the head, are not abſolutely neceſſary to exiſtence; one of each or two irregularly placed, would have conſtituted a race, incompleat, and imperfect indeed, but not ſufficiently ſo to have prevented its propagation and continuance. Many other parts and properties of various animals might have been wanting, which are not comprehended in the notion of bare exiſtence; whereas on the contrary, all our reſearches and obſervations convince us, that no creature could have any thing added to, or taken from it, without being rendered leſs perfect by the alteration.

In the next place what ſtronger proofs of divine wiſdom and deſign can we have, than that the offspring of rapacious animals are always ſcanty, and produced but ſeldom; and that thoſe of timid ones, and ſuch as are the prey of others, are brought forth more frequently, and in much larger numbers at a time. Who can contemplate the univerſality, and neceſſity of this wiſe regulation, and ſtill attribute it to a fortuitous origin?

To theſe inſtances of the wiſdom diſplayed at the creation, may be added a proof of the conſtant direction and ſuperintendance of the almighty in that nice ballance between the numbers of males and females of every claſs, which we may fairly conclude to be univerſal, both becauſe we find it obtains in all thoſe caſes which are ſubject to our computation, and becauſe in all others its effects are viſible, in the regular and undiminiſhed continuance of every ſpecies.

I ſhall add one argument more, which were all others wanting, would of itſelf be perfectly concluſive. If animals had been formerly produced by the heat of the ſun on the particles of matter, why are they not produced now? No monſtrous, or half formed creatures, are ever pretended to have been ſeen; no new animals are ever found but in newly-diſcovered countries, and when found are always obſerved to bear ſome relation and analogy to thoſe already known.

And here it is curious to obſerve, that although the hiſtory of nature, as well as that of empires, was in its earlier ſtages filled with fable and romance, and although many of the old naturaliſts, particularly the German ones, have ſhewn themſelves ſufficiently credulous, yet none of them have admitted or even pretended to have heard of any monſtrous or non-exiſting creatures, but ſuch as the poets have feigned, or thoſe that are allegorically mentioned in the ſcripture, ſuch us unicorns, griffins, dragons, mermaids, &c.

If then animals were formerly produced by the heat of the ſun and ſo forth, and are not ſo produced now, the advocates for that doctrine muſt either allow the agency of an almighty, ſuperintending power, in having put a ſtop to what was no longer neceſſary; or muſt admit the abſurd propoſition, that the ſame cauſes do not always produce the ſame effects.

The idea of ſpontaneous generation muſt have originated in the ſuperficial obſervations of the ignorant and vulgar, with whom, dirt and lice, fleas and filth are almoſt ſynonymous terms: but how a doctrine ſo wholly unſupported by facts, ſo replete with abſurdity, and ſo contradictory to every known law of nature, ſhould have been harboured by the more enlightened part of the world, it is difficult to imagine. All arguments founded on analogy are poſitively againſt it; for we never heard of any creature that was *known* to be ſo produced: and indeed its advocates, conſcious of this circumſtance, ſeem to have inverted the uſual mode of reaſoning, and to have adopted one more ſuited to their purpoſe; for aſſuming that cheeſe, putrid fleſh, ſtagnant waters, &c. *produce* animalcules, they argue, that if ſmall creatures can be thus ſpontaneouſly generated, larger ones certainly may.

This poſition, however abſurd it may appear, is not at all exaggerated; for it will be recollected that the author has actually argued in this manner; and ſo indeed have many other advocates for the ſame ſyſtem. As therefore the only pretended proofs in ſupport of it, have been drawn from the claſs of inſects, I ſhall add a few remarks on their nature and peculiar mode of propagation.

There are four circumſtances attending them, in which they materially differ from every other part of the creation; the combination of which, may, on a ſuperficial obſervation, excite the idea of equivocal generation. Firſt, the extreme minuteneſs of ſome of their eggs, which are ſcarcely viſible with the beſt microſcopes. Secondly, the hidden and dirty places in which they are depoſited; ſome being laid in putrid fleſh, in ſtagnant waters, in the ſtinking lees of fermented liquors, &c. others, by means of an apparatus furniſhed for that purpoſe, being thruſt into the fleſh of living animals, and into the leaves, bark, and fruit of various plants. Thirdly, the abſolute abandonment of the eggs as ſoon as they are lodged, and the young being never fed or cheriſhed by the parents after their excluſion: and laſtly, the maggot or nympha ſtate in which they firſt appear, being ſo totally different from that perfect and winged form, in which they depoſit their eggs.

Whoever conſiders the reſult of theſe circumſtances muſt allow, that, to an incurious eye, creatures will ſometimes appear in places, where it ſeems impoſſible to attribute their exiſtence but to equivocal generation. If for inſtance a piece of fleſh be cut from an animal, and immediately put on top of an high ſteeple, an uninformed obſerver will wonder at ſeeing it in a few days covered with maggots, which he will perceive from their formation could not have crept there, and which he will therefore conclude to have been *produced* by the fleſh: but his wonder will ceaſe when he is told, that the maggots ariſe from the eggs of a winged inſect; that their proper nidus is the fleſh of animals, which this fly has a faculty of ſcenting at a vaſt diſtance; and that after having undergone two transformations, they will become winged like their parents.

I cannot omit this opportunity of remarking on the evident wiſdom and deſign of providence in the propagation of this inſect. All others, during their nympha or maggot ſtate, grow ſlowly, and arrive at their full ſize in one, two, three, or four months reſpectively; but this alone attains its maturity, and undergoes its firſt transformation in a few days: without this wiſe deſtination, the fleſh, which is both a nidus and food to it, would ſoon become too putrid and rotten to ſerve either purpoſe, and the exiſtence of the ſpecies be deſtroyed.

The appearance of all other inſects and animalcules will, when inveſtigated, be as eaſily ſolved, as that of the kind above mentioned. Every tree and plant, and indeed almoſt every ſubſtance whatever, whether animal or vegetable, has a ſpecies to which it affords retreat and nouriſhment. Theſe remain ſeverally the ſame through all ſucceſſions, as to colour, form, manners, and attachments, and one generation is in every reſpect like all the preceding ones.

As to thoſe ſmaller kinds, which are diſtinguiſhed by the appellation of microſcopick inſects, were the idea of equivocal generation admitted, it muſt be expected that thouſands of all ſhapes and kinds would be found on every new inſpection; whereas on the contrary, with all our reſearches, not more than four or five kinds have ever been diſcoverd in ſtagnant waters, nor more than eight ſorts in all the mixtures and infuſions of vegetables that have yet been made.

Another reaſon why this claſs of beings is more peculiarly ſubject to the ſtigma of chance production, ariſes from the epithets of *contemptible* and *imperfect*, which even the beſt writers have inadvertently but erroneouſly applied to them. They are certainly contemptible only as they are ſmall, and ſo far only as theſe ideas are ſynonymous is the term properly applied: but they can be called imperfect in no ſenſe of the word. A worm is no more imperfect becauſe it cannot fly, than a bird becauſe it cannot penetrate the earth; nor is a gnat leſs perfect for being extremely ſmall, than an elephant for being very large; each can perform many things which the other cannot; and all can do thoſe things in the moſt perfect manner, which are proper and neceſſary to their reſpective ſituations.

Perhaps too we ſhall find that another cauſe of this doctrine is the apathy and indifference with which we look at the wonders of the creation; for being ſurrounded and familiar with them from our infancy, and the effect of novelty being wanting to excite our attention, we paſs them over with a careleſs eye, and are not often rouſed to examine them even with the attention which we beſtow on the works of art.

There ſeems to be this characteriſtick diſtinction between the works of nature and thoſe of art: the former will always raiſe our wonder and admiration, in proportion to the degree with which we ſcrutinize them; and the latter, as far as their excellence depends on manual execution, will as aſſuredly excite our ridicule and contempt. If, for inſtance, we look at the ſting of a bee in a microſcope, we ſhall perceive, that the conſtruction of it is moſt exquiſitely adapted to its purpoſe, and that the point, though magnified ever ſo much, ſtill retains the ſame viſible perfection, as if it had been really formed of the apparent ſize: but if the fineſt needle is viewed in the ſame manner, we ſee nothing like a point, and the miſerable ragged end ſcarcely appears as an attempt towards it.

Is it not therefore ſurpriſing that any perſons ſhould adopt a mode of reaſoning, reſpecting the works of God Almighty, which, if applied to thoſe of our bungling hands they would preſently ſee the abſurdity of. I would aſk one of thoſe advocates for ſpontaneous generation, whether when he has looked at a fiddle or a harpſichord, it ever entered into his imagination that they were produced by chance? He will doubtleſs anſwer, That it did not. How much leſs then ought organized bodies to be attributed to that principle, compared with the meaneſt of which, the higheſt works of art are poor indeed.

After all, I am afraid that theſe philoſophers, as they call themſelves, are, in general, not ſkeptics on this point alone, but that a diſbelief of the divine agency in the creation of the world, is only one part of a more extended ſyſtem of infidelity. To ſuch I do not addreſs myſelf. Fools cannot, and mad men will not be taught. But if there are any, who, independent of ſyſtem, and without any view or conſideration of its evil tendency, really imagine that animals and vegetables do ſometimes ariſe ſpontaneouſly from the earth, I truſt, the few hints here given may tend to convince them of their error.

7 AP 66

FINIS.